

**NERRS Science Collaborative Progress Report**  
**Period: 09/01/13 through 02/28/14**

**Project Title:** *Legacy effects of land-use change and nitrogen source shifts on a benchmark system: Building capacity for collaborative research leadership at the Grand Bay Reserve*

**Principal Investigator(s):**

Ruth H. Carmichael, Ph.D., Dauphin Island Sea Lab, Dauphin Island, AL

**Project start date:** 09/15/10

**Report compiled by:** R. H. Carmichael (PI)

**Contributing team members and their role in the project:**

***Co-Is & Integration Lead***

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Name (Integration Lead): William Walton (coordination, communication with end users)

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***End-user Participants (formal, in proposal)***

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Name: H. Edwin Jackson (shell midden access, data consultation and application)

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Name: Barbara Holley Reid, J.D. (community and working waterfront interests)

\*Mrs. Reid passed away in early 2011.

Name: CAPT Kathy Wilkinson (ecotourism)

Title: Owner/Operator

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**A. Progress overview:** State the overall goal of your project, and briefly summarize in one or two paragraphs, what you planned to accomplish during this period and your progress on tasks for this reporting period. This overview will be made public for all reports, including confidential submissions.

***Research goal***

To measure land-use related N source and pathogen changes through time and define the resulting effects on ecosystem and human health in Grand Bay, AL by combining data from land-use models, sediment cores, modern sediment and water samples, ancient shell middens, living native and transplanted bivalves, and environmental attributes that cover time periods from up to 3000 years before present to 2020 for three subwatersheds and their receiving waters.

***Planned activities and anticipated accomplishments***

For this term (Y4 NCE: Q1 & Q2), we focused on completing tasks that were initiated under a No Cost Extension in response to stake holder interests. Specifically, we filled gaps in our land-use land cover change dataset, updated maps, refined timelines from sediment core data, analyzed stable isotope data from shell middens, held a final Working Group meeting to plan for our culminating end-user workshop, and continued overall data analysis and writing. We regularly updated our Facebook page and discussion board. We also focused on expanding our stakeholder list to identify the most suitable participants to invite to our final Workshop. Data from this project were leveraged to support a proposal funded through the Mississippi Water

Resources Research Institute. The proposal focused on quantifying phosphate discharge into Bangs Lake within the Grand Bay reserve boundary, which was identified by our study in 2012. We also continued training students, technicians, and interns on scientific methods.

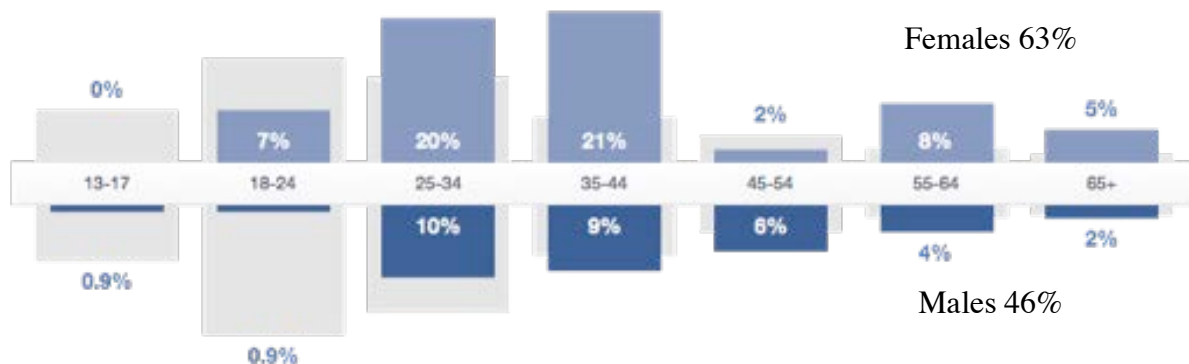
## B. Working with Intended Users:

- Describe the progress on tasks related to the integration of intended users into the project for this reporting period.
- What did you learn? Have there been any unanticipated challenges or opportunities?
- Who has been involved?
- Has interaction with intended users brought about any changes to your methods for integration of intended users, the intended users involved, or your project objectives?
- How do you anticipate working with intended users in the next six months?

1. We continue our collaboration with end user Dr. Ed Jackson to date midden shell samples and collect data that complements his existing data set.
2. Integration Lead, Walton and graduate student Beth Darrow Condon (and PI Carmichael, to a lesser degree) maintained the project Facebook Page:  
<http://www.facebook.com/pages/Grand-Bay-National-Estuarine-Research-Reserve-Science-Collaborative/153046948084497> (open to the public)

Current ‘likes’ count of 123 (up 11% from the last report), with typically 50 viewers per post. Posts include research updates and images, particularly by graduate student Darrow. This venue was useful during this term to update participants, local agencies (Mobile Area Water and Sewer System, MS Department of Archives and History) and Grand Bay Reserve personnel on project outputs and advertise a public seminar. In particular, the ‘Reach’ (defined as the number of unique individuals who have actually seen any content related to the Facebook Page) was substantial (Fig. 1).

**Fig. 1.** Current demographics (age classes) for the Grand Bay National Estuarine Research Reserve Science Collaborative Facebook Page, as of 21 Feb 2014.



3. PI Carmichael and Graduate student E. Darrow participated in the Grand Bay NERR Research Symposium, where we interacted with other researchers, managers, and stakeholders. End-user participant, Dr. Ed Jackson also participated in the Symposium, which provided an opportunity for communication on the shared project outputs.
4. PI Carmichael gave a presentation and student E. Darrow and an intern participated in the MS DMR and Grand Bay NERR Fall Seminar series, where we interacted with local stakeholders and the public. Enduser participant, Dr. Ed Jackson also participated in the Seminar series, which provided an opportunity for communication on project outputs.
5. PI Carmichael and Co-PI Ruple (GBNERR) met via conference call with collaborators from University of West Florida, University of Southern Mississippi, and other Grand Bay NERR staff to discuss the recurring phosphate spilling into Bangs Lake within the reserve.
  - a. Carmichael shared data and research experiences in area
  - b. The group decided to develop and submitted a proposal to MS Water Resources Research Institute to gather more data to characterize the spill relative to a local phosphate plant.
  - c. The proposal was funded to begin in summer 2014 and will support at least 6 students to collect data and gain research experience.

This relatively small-scale project is expected to seed a larger proposal in the future.

#### **C. Progress on project objectives for this reporting period:**

- Describe progress on tasks related to project objectives for this reporting period.
- What data did you collect?
- Has your progress in this period brought about any changes to your methods, the integration of intended users, the intended users involved or the project objectives?
- Have there been any unanticipated challenges, opportunities, or lessons learned?

#### ***Stakeholder participation***

In addition to the stakeholder involvement described above, during this quarter we focused on planning for our culminating stakeholder workshop. The meeting will be held in late summer/early fall 2014, roughly 6 weeks before the end of the No Cost Extension period. Our goal is to present information to endusers at a workshop/ seminar style meeting at which we provide a summary of findings and examples of possible project outputs, then allow participants to break into smaller groups to discuss possible means of displaying and sharing data (output forms). We also will ask participants to share ideas for other useful outputs and applications. We will spend the final weeks of the project period responding to these specific enduser requests, either by producing the requested products or developing a plan for production if additional funds are required. Larissa Graham, the Grand Bay NERR Coastal Training Program Coordinator participated in our final Working Group meeting to consult on Workshop development and has agreed to assist with coordinating and directing the effort based on her experience with similar programs designed to build participation and consensus. Marian Hanisko, a Coastal Management Specialist with The Baldwin Group, NOAA OCRM/ CSC, has also agreed to help develop an agenda and facilitate the breakout sessions to enhance our efforts.

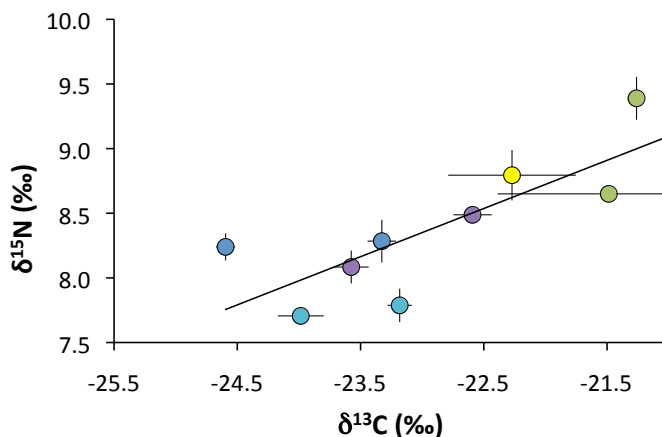
### ***Field sampling, lab work and data analyses***

*Sediment cores*— Stable isotope ratios (C, N), %C and N, including analytical replicates, Pb-<sup>210</sup> data from all sites, and sediment grain size datasets were completed. We are currently working with the analytical lab that dated our sediment core samples, to determine the range of error in the dates from downcore sections. It has proven to be a challenge to interpret these dates, but we are reaching out to colleagues to improve and corroborate our Pb-<sup>210</sup> data.

*Oyster transplants*—We completed all oyster growth measurements, stable isotope analyses for 2011 (Figs. 1 & 2), and stable isotope preparations for 2012-2013, ratios are pending for 2012-2013. A Directed Study student from University of Illinois-Urbana Champagne completed analyses of length to dry weight comparisons among age/size classes, transplanted v. native oysters, and between our sites on the Gulf of Mexico coast with similar data collected on the U.S. Atlantic coast. She is preparing to defend this work as part of her Masters' Thesis in the next quarter.

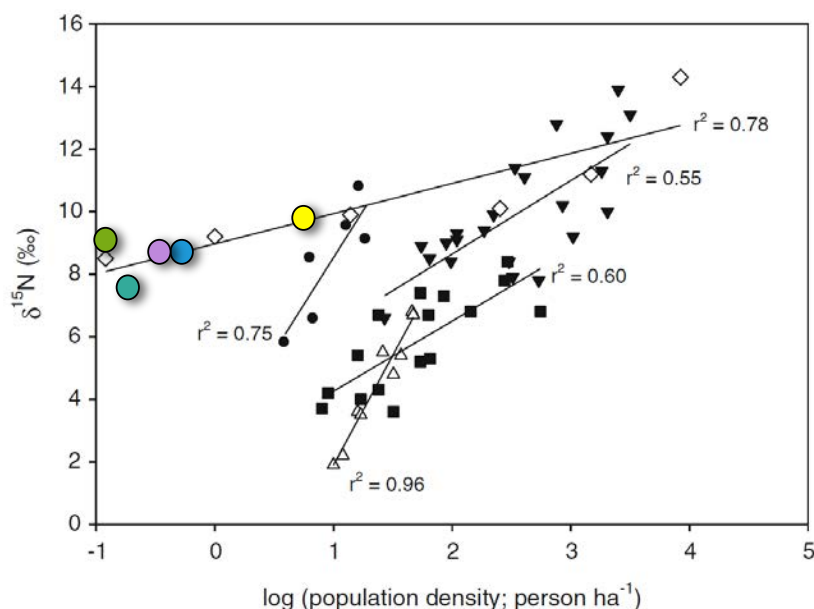
*Environmental & microbial data*—We completed analyses of chlorophyll *a* and suspended particulate matter for 2012-2013. All YSI data sonde collected environmental data have been quality checked.

*Oyster shells* (modern and midden)—We completed analysis on midden shells, including method development for N and C content on an elemental analyzer to optimize amount of oyster shell to be analyzed; we are awaiting some final stable isotope ratios. Oyster shell banding patterns were analyzed for four seasons during the 2012-2013 transplant study.



**Figure 1.** Stable isotope ratios in adductor muscle of oysters transplanted at 5 sites in Grand Bay (site mean  $\pm$  se,  $n=4$ ), once tissues had reached equilibrium with the environment ( $\sim 6$  wks). (Bayou Chicot = yellow, Bangs Lake = turquoise, Bayou Cumbest = blue, Point aux Chenes Bay = green, Bayou Heron = purple. An upstream site at Bayou Chicot was excluded as an outlier ( $F_{1,8} = 11.88$ ,  $p = 0.011$ ,  $r^2 = 0.63$ ). Darrow et al. in prep.

At each site, oysters captured and assimilated particles representing a range of organic carbon sources, with significantly different  $\delta^{13}\text{C}$  values at upstream (depleted) compared to downstream (enriched) locations. Oyster  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$  values were positively correlated, except for the Chicot Upstream site, where higher than expected  $\delta^{15}\text{N}$  values suggest more intensive microbial processing (denitrification) of sewage-derived nitrogen.



**Figure 2.** Cross-study comparison of land use effects on  $\delta^{15}\text{N}$  values in animal tissues. Results from this study (colored circles, using the same color code as in Fig. 1) follow a similar pattern to those reported elsewhere (Hoffman et al. 2012, Karube et al. 2010, Elliott and Brush 2006, Mayer et al. 2002, Bannon and Roman 2008; modified from Hoffman et al. 2012). Darrow et al. in prep.

### ***Changes in Methods***

Due to the low organic content of ancient oyster shells, graduate student Darrow experimented with different methods for extracting organic matter from shells for SIA. The centrifugation method she developed may be able to quantify %N in shell as well (*results pending*).

Darrow began a collaboration with the stable isotope laboratory at UNC Wilmington, which will allow her to run SIA samples more quickly and less expensively. She is currently running tests to compare results between this lab and UC Davis, where samples previously were analyzed. This new collaboration will provide faster turnaround for remaining samples.

### ***Opportunities***

1. Darrow and Carmichael began a collaboration with new DISL faculty member Dr. Jeff Krause, to analyze archived sediment core samples for biogenic silica (BSi), an indicator of diatom abundance. Darrow assisted with sampling. Krause is developing a new method to quantify bound BSi, using our samples to test the method. Our project will benefit from links between historical nutrient sources and relative diatom contribution to the sediment organic source pool.
2. Oyster midden shell inorganic stable isotope data from Darrow's work in the Andrus lab (previous quarter) will be incorporated into at least one manuscript that will be of interest to schlerochronologists and archaeologists, since it is the first report of  $\delta^{18}\text{O}/\delta^{13}\text{C}$  profiles (temperature proxy) from this region and can assist in defining the season of capture by native Americans. These results will be useful to endusers at the MS Department of Archives and History and Dr. Ed Jackson's work.
3. Data from this project were leveraged to support a proposal funded through the Mississippi Water Resources Research Institute. The proposal focused on quantifying phosphate discharge into Bangs Lake within the Grand Bay reserve boundary, which was identified by our study and Grand Bay NERR SWMP data during fall 2012.

### ***Technical training***

- PI Carmichael and Darrow continued training on shell slicing and acidification techniques in the Carmichael lab for application to midden shells. Darrow has developed new methods and some specialized techniques.
- Darrow incorporated a number of students into the project to assist with field and lab work. These students were able to learn techniques such as water quality sampling, oyster sampling, isotope filtering, and YSI data sonde calibration and data analysis. Interns during this quarter included:
  - a. Amanda Ellenburg (University of South Alabama)
  - b. Renee Edwards (University of Illinois – Urbana Champagne)

### ***Land-use modeling***

Co-PIs from GCRL continued refining land cover land use mapping. Specifically these tasks included 1) Improving the 2020 landscape predictions by accounting for sea-level rise effect, 2) obtaining 1955, 1979 and 1988 national wetland inventory data, and 3) performing land change analyses on these data in tandem with the more recent land use/land cover maps (1980 - 2000s) derived and reported before.

- What are your plans for meeting project objectives for the next six months?
  1. Final analysis of sediment core data, and inclusion in landscape models to show historical land cover change effects on N and organic matter sources to the Grand Bay watershed; preparation and submission of manuscript.
  2. Final data analysis from oyster transplant experiments, preparation of manuscript.
  3. Other manuscripts will be in process (*e.g.*, oyster shell, wastewater stable isotope and microbial assessments).
  4. Development of predictive models incorporating land cover change, water quality, and biological/ecological indicators (testing a structural equation modeling approach).
  5. Final Outreach Workshop will be planned and conducted at the Grand Bay NERR.
  6. Production of enduser accessible data products (*e.g.*; historical and predicted land cover maps in a format useful to the end users (as determined by our upcoming workshop).

**D. Benefit to NERRS and NOAA:** List any project-related products, accomplishments, or discoveries that may be of interest to scientists or managers working on similar issues, your peers in the NERRS, or to NOAA. These may include, but are not limited to, workshops, trainings, or webinars; expert speakers; new publications; and new partnerships or key findings related to collaboration or applied science.

1. See results from dating efforts above.

2. Ongoing collaboration with the Grand Bay NERR and EPA project by Dr. J. Cebrian, expansion to collaborate with Dr. K. Dillon at University of Southern Mississippi/ Gulf Coast Research Laboratory and Dr. J. Caffrey at University of West Florida regarding the phosphate spill in Bangs Lake; secured additional funding to identify source and environmental effects of the spill(s).

This success demonstrates that our NERR NSC funded work has met a major goal of our project, to increase capacity for research at the reserve and increase opportunities for collaboration to answer relevant management questions.

3. PI Carmichael and Darrow shared data and participated in discussions at the Grand Bay NERR Symposium and Seminar Series, with outreach to other researchers, managers, and the public.
4. Intern A. Ellenburg also presented a poster at the Grand Bay NERR Symposium, sharing data and gaining valuable scientific communication and outreach training.
5. PI Carmichael and Darrow presented data at the Coastal and Estuarine Research Federation meeting in San Diego to broaden the project reach.
6. Darrow was awarded a competitive travel grant from the Wetland Foundation, supplemented by a Gulf Estuarine Research Society travel award, recognizing the value of her research in Grand Bay and funding her travel to present this research at the Coastal and Estuarine Research Federation (CERF) meeting in San Diego.

### ***Oral presentations***

**Darrow, E.S., R.H. Carmichael, K.R. Calci, W. Burkhardt III.** “Are stable isotopes alone sensitive enough to trace small-scale effects of land-use change?” Oral presentation, Coastal and Estuarine Research Federation Biennial Meeting, San Diego, CA: November 3-7, 2013.

**Carmichael, R.H., D. Dalrymple, C. Kovacs, E. Darrow, P. Biancani.** “Nitrogen in bivalve shell & soft tissues: Implications for N sequestration and cycling in coastal waters.” Oral presentation, Coastal and Estuarine Research Federation Biennial Meeting, San Diego, CA: November 3-7, 2013.

**Carmichael, R.H., E. Darrow, W. Burkhardt, III, K. Calci, W. Wu, D. Ruple, W. Walton .** “Legacy effects of land-use change and nitrogen source shifts on Grand Bay, Mississippi: a benchmark for building collaborative research at the Grand Bay NERR” Invited oral presentation, Grand Bay NERR Research Symposium, October 25, 2013. (given by Carmichael and Darrow)

**Carmichael, R.H., E. Darrow, D.J. Dalrymple.** “Using oyster shells to trace historical nitrogen sources to Grand Bay Mississippi” Invited oral presentation, MS Department of Marine Resources/ Grand Bay NERR, Fall Science Seminar, Oysters: Science on the half shell, October 24, 2013 (announcement attached).

### ***Poster presentation***

**Ellenburg, A., E. Darrow, R.H. Carmichael.** “Seasonality of chalky deposits within shells of oysters grown in Grand Bay NERR, MS, Grand Bay NERR Symposium, Grand Bay, MS October 25, 2013.



### *Abstract*

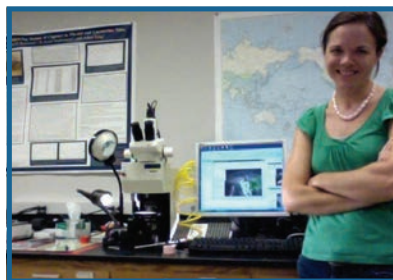
**Carmichael, R.H.**, D. Dalrymple, C. Kovacs, **E. Darrow**, P. Biancani. "Nitrogen in bivalve shell & soft tissues: Implications for N sequestration and cycling in coastal waters." Goldschmidt 2013, Mineralogical Magazine.

### *Proposal*

MS Water Resources Research Institute (MWRRI), "Water quality in Bangs Lake: Effects of recurrent phosphate spills into a coastal estuary", K. Dillon (MSU), **R. Carmichael** (DISL/USA), J. Caffrey (UWF), **D. Ruple** and **M. Woodrey** (GBNERR).

**T**he Mississippi Department of Marine Resources and the Grand Bay National Estuarine Research Reserve invite you to attend our Fall Science Seminar:

## OYSTERS: SCIENCE ON THE HALF SHELL



### **Fall Science Seminar Thursday, October 24th 6:00pm - 8:00pm**

First Floor Commission Meeting Room  
Mississippi Department of Marine Resources  
1141 Bayview Avenue, Biloxi, MS 39530

***No registration required***

#### **PRESENTATIONS:**

"The archaeology of Grand Bay Shell Middens:  
3000 Years of Fishing and Foraging"  
by Ed Jackson, University of Southern Mississippi

"Using oyster shells to trace historical nitrogen  
sources to Grand Bay, Mississippi"  
by Ruth Carmichael, Dauphin Island Sea Lab

"Mississippi Oyster Management and Restoration"  
by Bradley Randall, MS Dept of Marine Resources

"Irradiated vs. Quick Frozen: How oysters are treated  
after harvest"  
by Jennifer Jenkins, Crystal Seas Seafood and  
Ryan Hollingsworth, Gateway America

***Stay for our oyster "taste test"  
after the presentations!***

### **Don't miss out!**

"The first man gets the oyster, the second  
man gets the shell." - Andrew Carnegie



First Floor Commission Meeting Room  
Mississippi Department of Marine Resources  
1141 Bayview Avenue, Biloxi, MS 39530

**E. Describe any activities, products, accomplishments, or obstacles not addressed in other sections of this report that you feel are important for the Science Collaborative to know.**

None.